FIG. 1

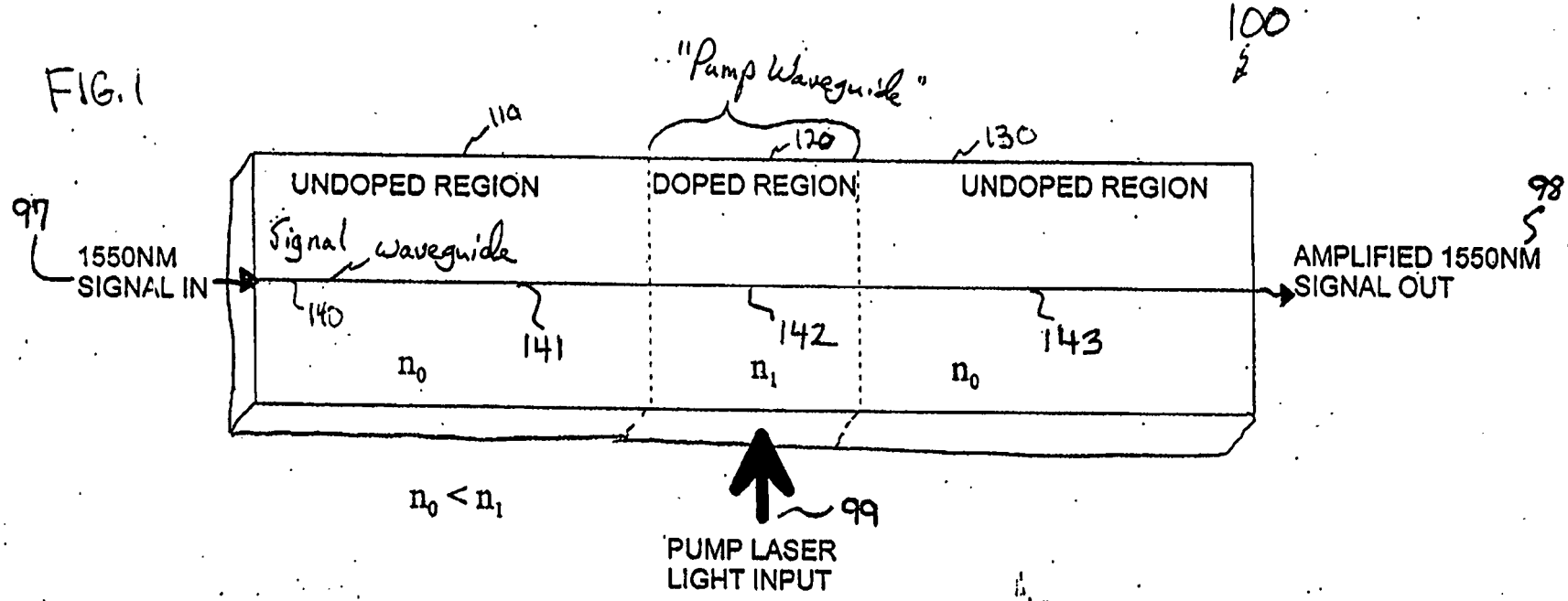


FIG. 2

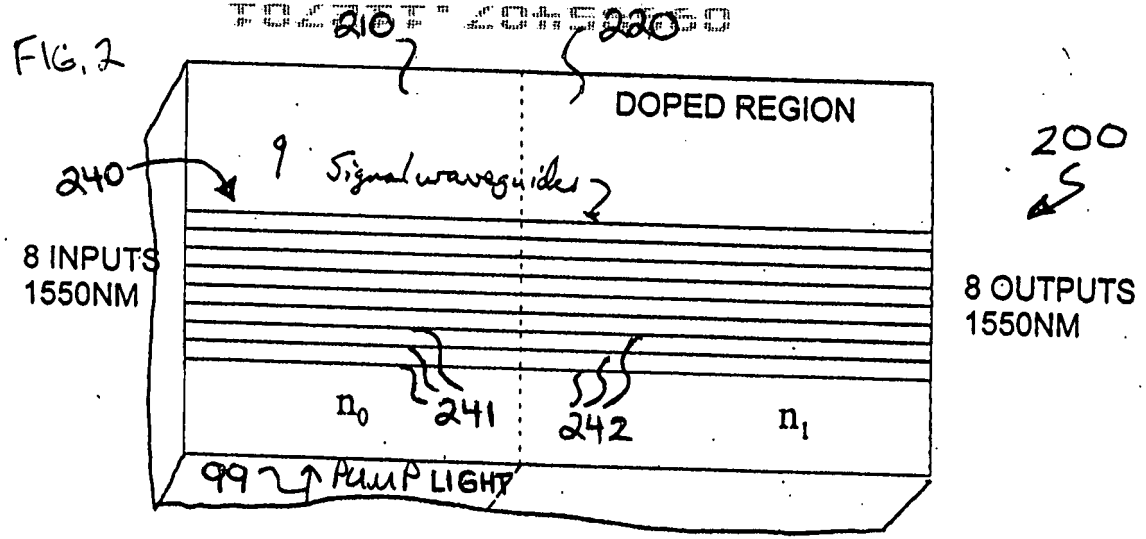

210
220
DOPED REGION
240
9 Signal waveguides
200
8 INPUTS
1550NM
8 OUTPUTS
1550NM
n_0
241
242
n_1
99
PUMP LIGHT

FIG. 3

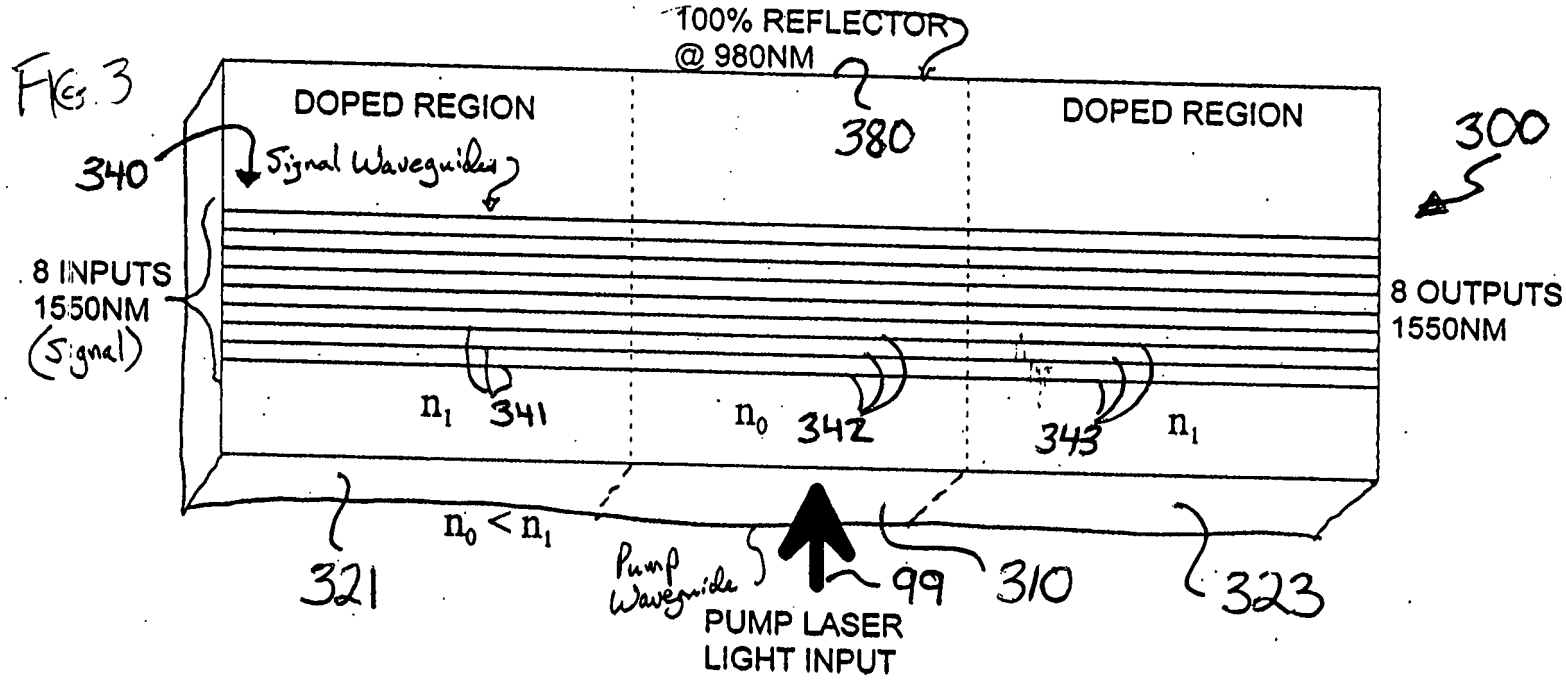

100% REFLECTOR
@ 980NM
380
DOPED REGION
DOPED REGION
340
Signal Waveguides
300
8 INPUTS
1550NM
(Signal)
8 OUTPUTS
1550NM
n_1
341
n_0
342
343
n_1
$n_0 < n_1$
321
Pump
Waveguide
99
310
323
PUMP LASER
LIGHT INPUT

FIG. 4

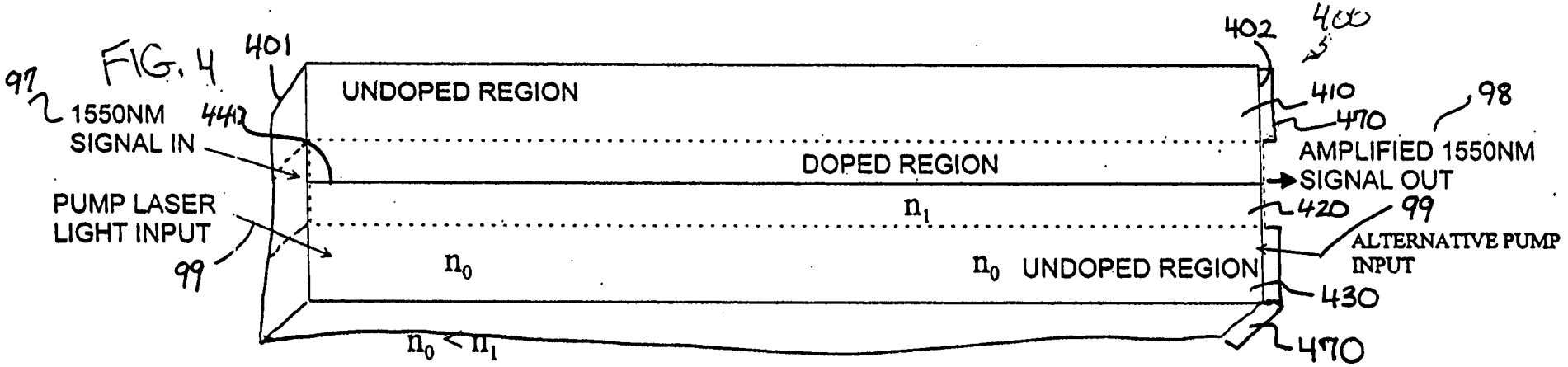

401
402
400
97
1550NM
SIGNAL IN
442
UNDOPED REGION
410
470
98
AMPLIFIED 1550NM
SIGNAL OUT
DOPED REGION
n_1
420
99
PUMP LASER
LIGHT INPUT
99
n_0
n_0 UNDOPED REGION
ALTERNATIVE PUMP
INPUT
430
$n_0 < n_1$
470

FIG. 5

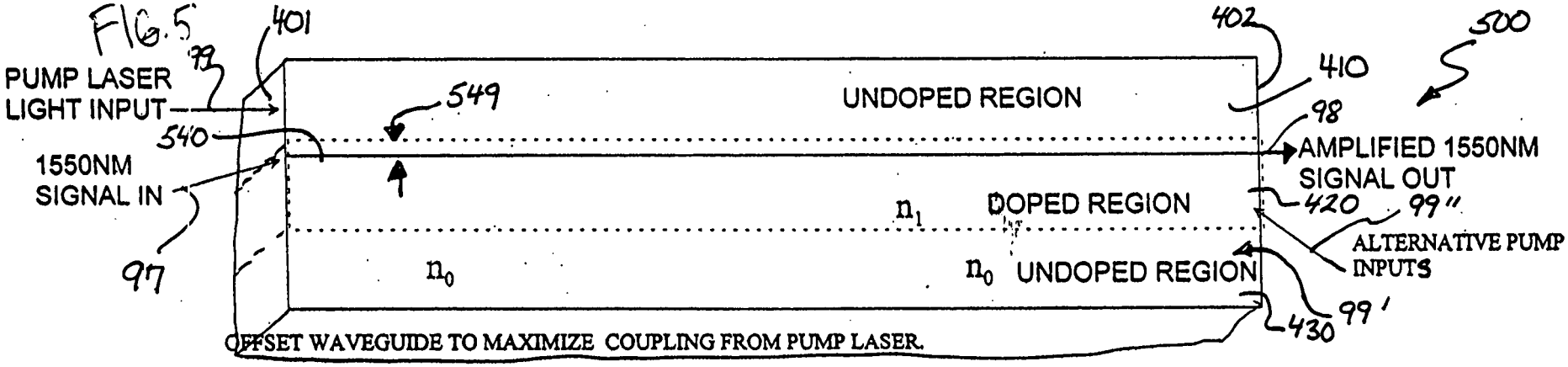

401
402
500
PUMP LASER
LIGHT INPUT
97
549
UNDOPED REGION
410
98
540
AMPLIFIED 1550NM
SIGNAL OUT
1550NM
SIGNAL IN
n_1
DOPED REGION
420
99"
97
n_0
n_0 UNDOPED REGION
ALTERNATIVE PUMP
INPUTS
99'
430
OFFSET WAVEGUIDE TO MAXIMIZE COUPLING FROM PUMP LASER.

FIG. 6

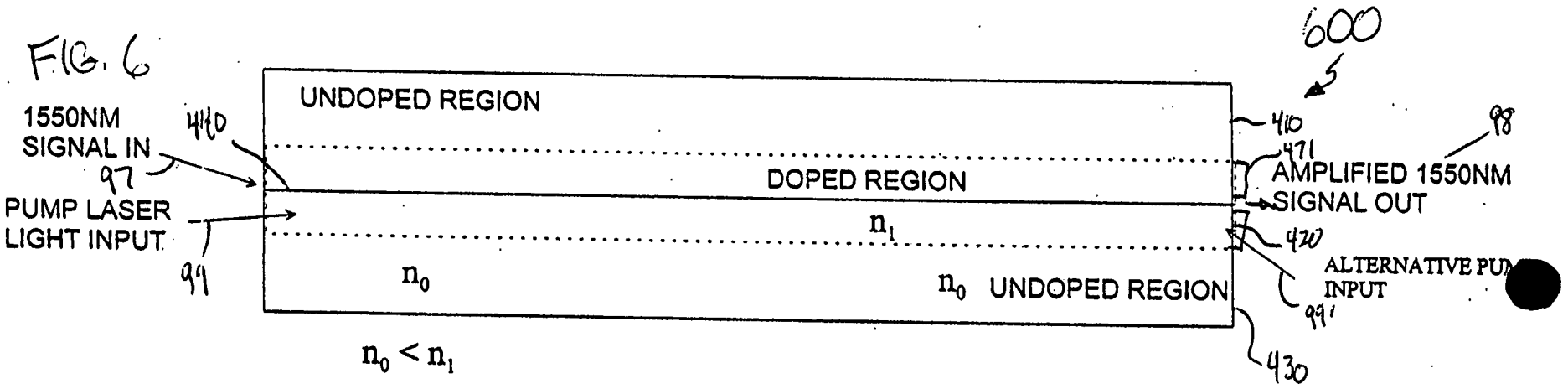
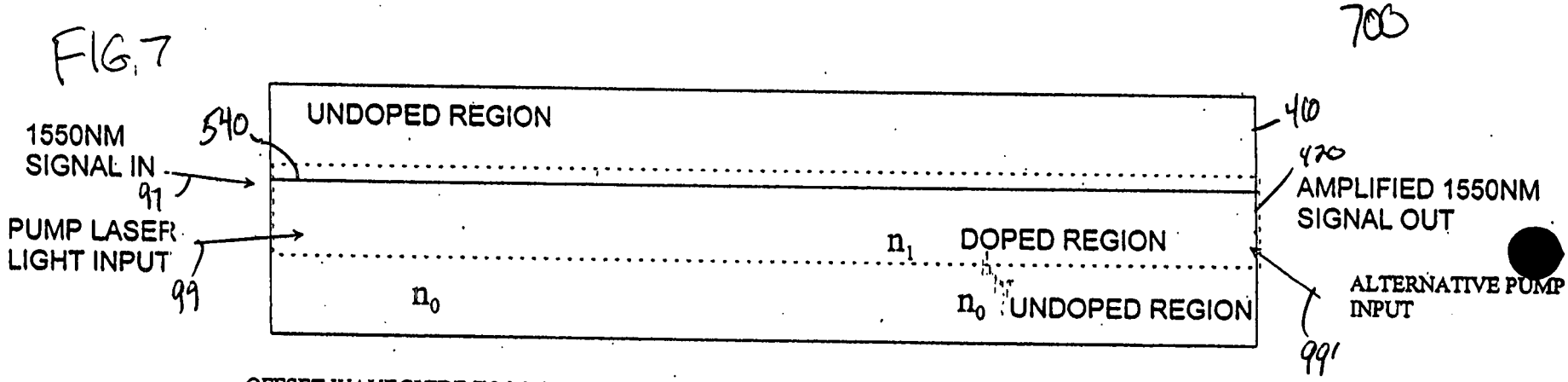


FIG. 7



OFFSET WAVEGUIDE TO MAXIMIZE AREA FOR PUMP LAUNCH.

FIG. 8

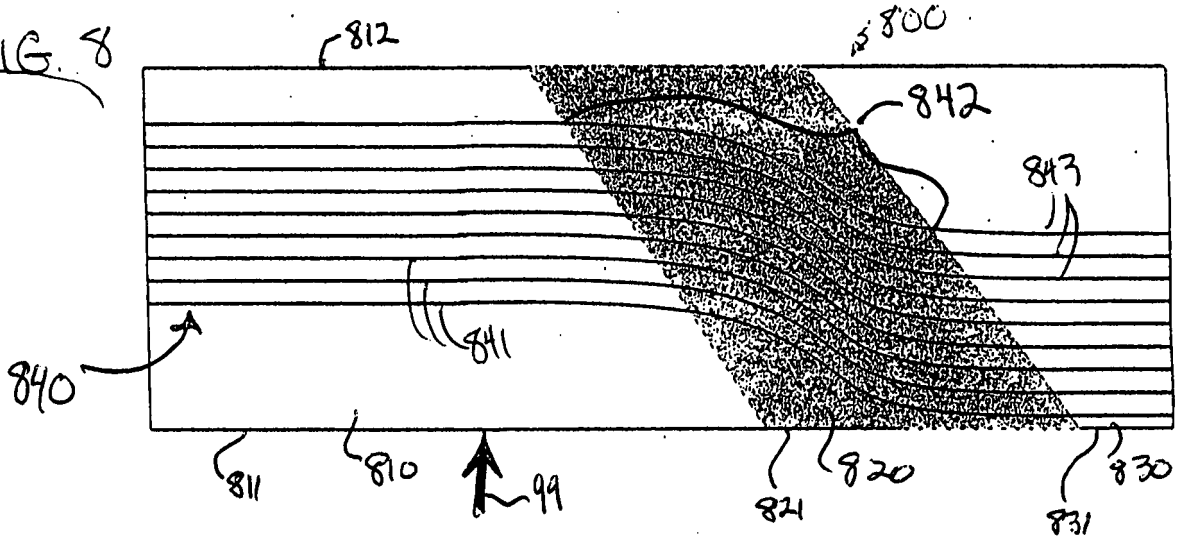
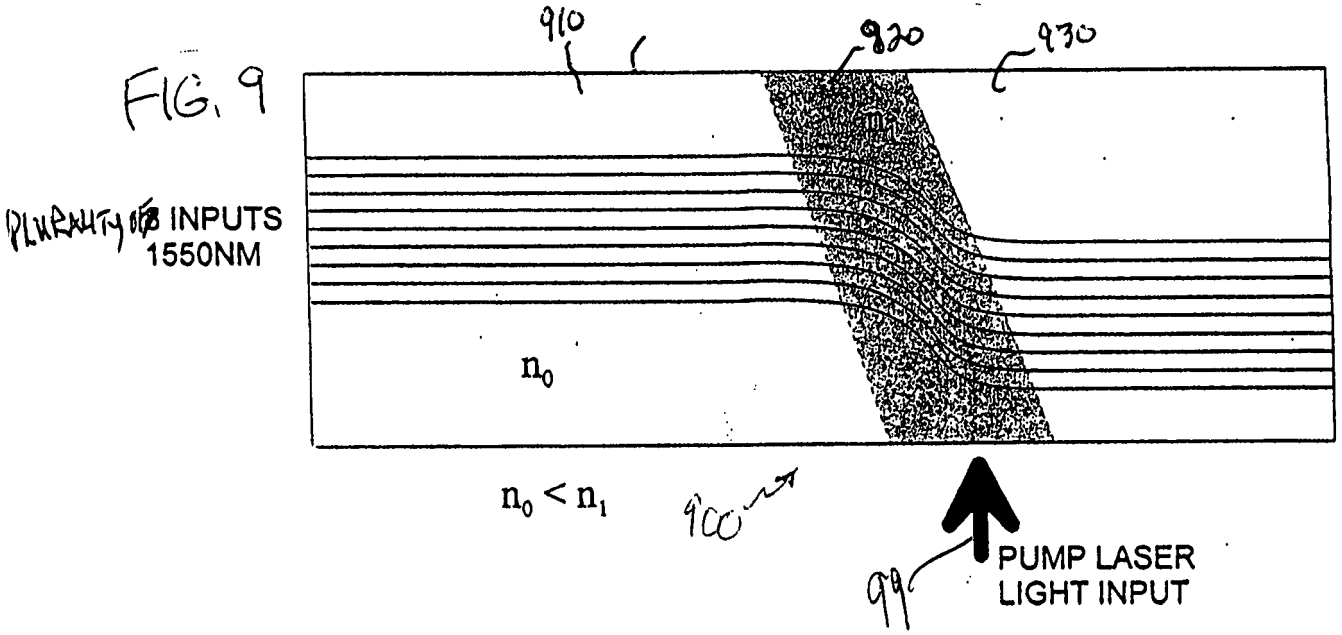

812
800
842
843
841
840
811
810
99
820
821
830
831

FIG. 9


910
920
930
PLURALITY OF INPUTS
1550NM
n_1
n_0
$n_0 < n_1$
900
99
PUMP LASER
LIGHT INPUT

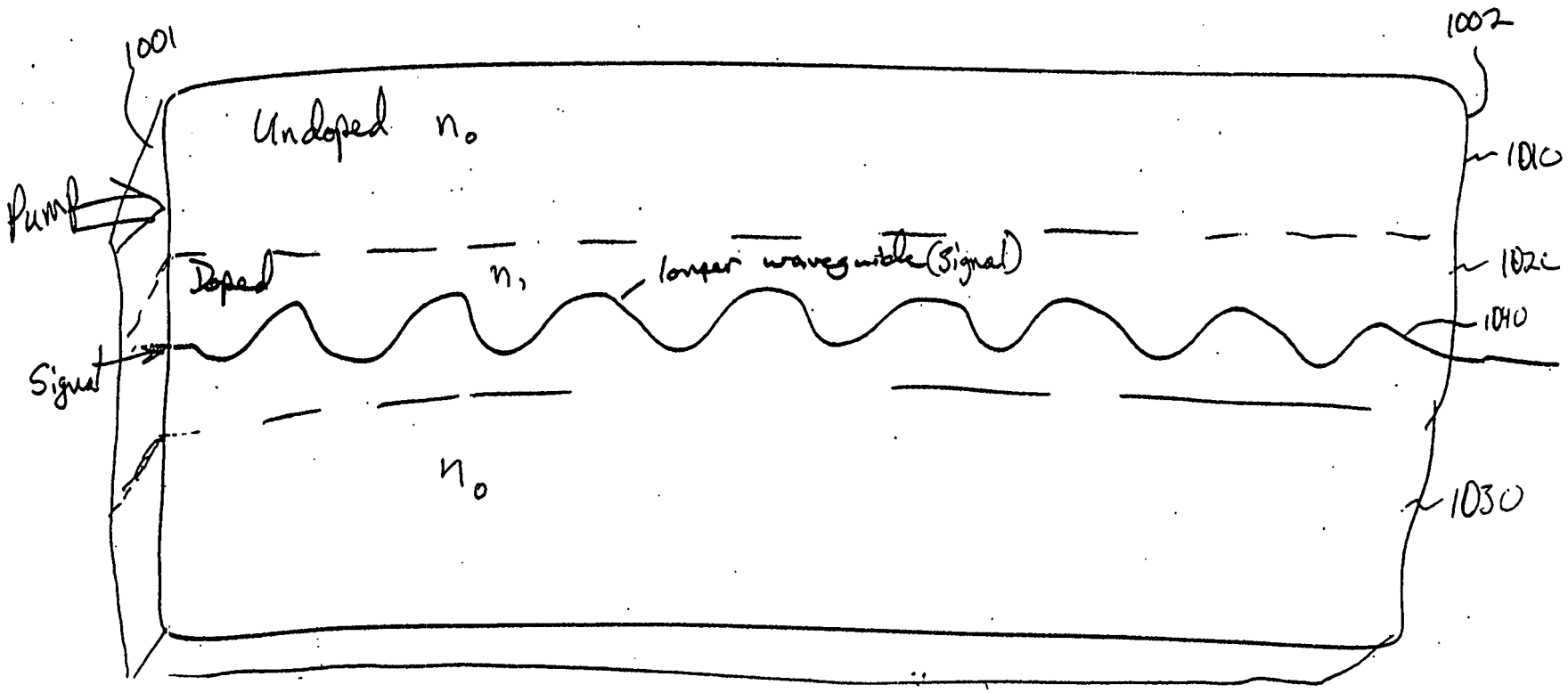

1001
1002
Undoped n_0
Pump
Doped
n_1
lower waveguide (Signal)
Signal
n_0
1010
102c
1040
1030

FIG. 10

1000

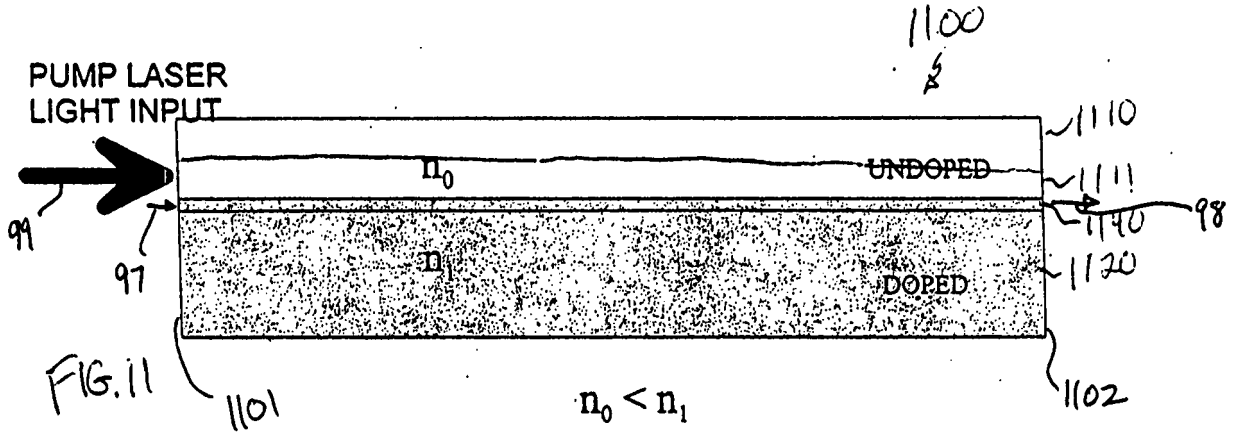

1100
PUMP LASER
LIGHT INPUT
1110
n_0
UNDOPED
1111
99
97
1140
98
n_1
DOPED
1120
1101
1102
$n_0 < n_1$

FIG. 11

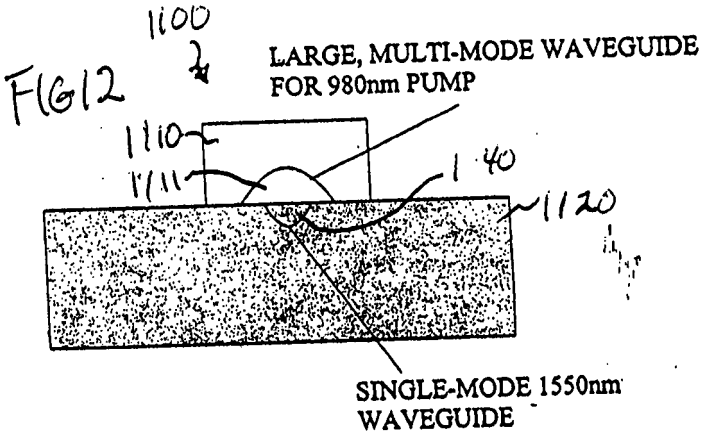

1100
LARGE, MULTI-MODE WAVEGUIDE
FOR 980nm PUMP
1110
1111
1140
1120
SINGLE-MODE 1550nm
WAVEGUIDE

FIG 12

FIG. 13

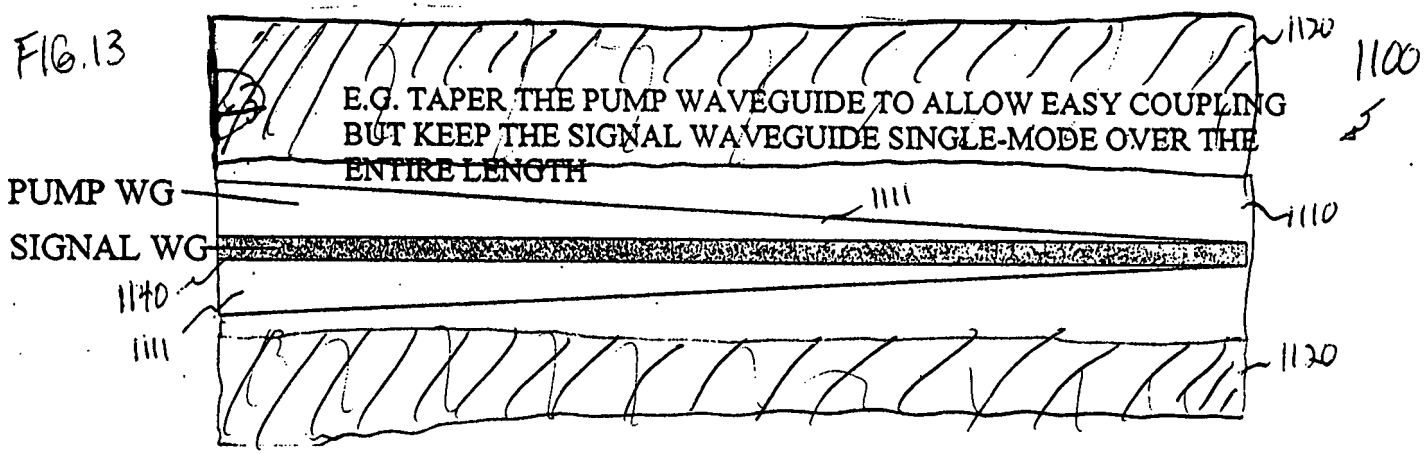

E.G. TAPER THE PUMP WAVEGUIDE TO ALLOW EASY COUPLING BUT KEEP THE SIGNAL WAVEGUIDE SINGLE-MODE OVER THE ENTIRE LENGTH
PUMP WG
SIGNAL WG
1120
1100
1111
1110
1140
1111
1120

FIG. 14

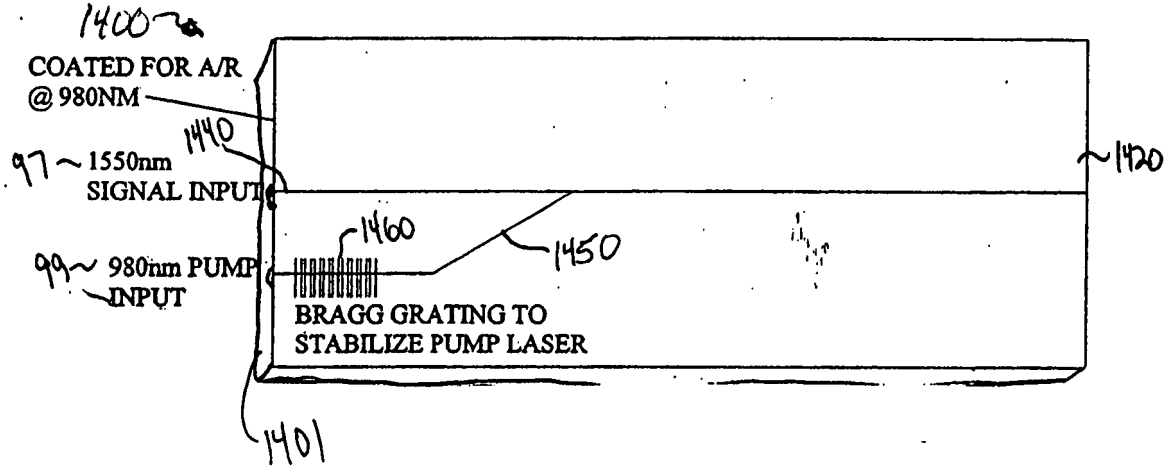

1400
COATED FOR A/R @ 980NM
1440
97 ~ 1550nm SIGNAL INPUT
1460
1450
99 ~ 980nm PUMP INPUT
BRAGG GRATING TO STABILIZE PUMP LASER
1420
1401

FIG. 15

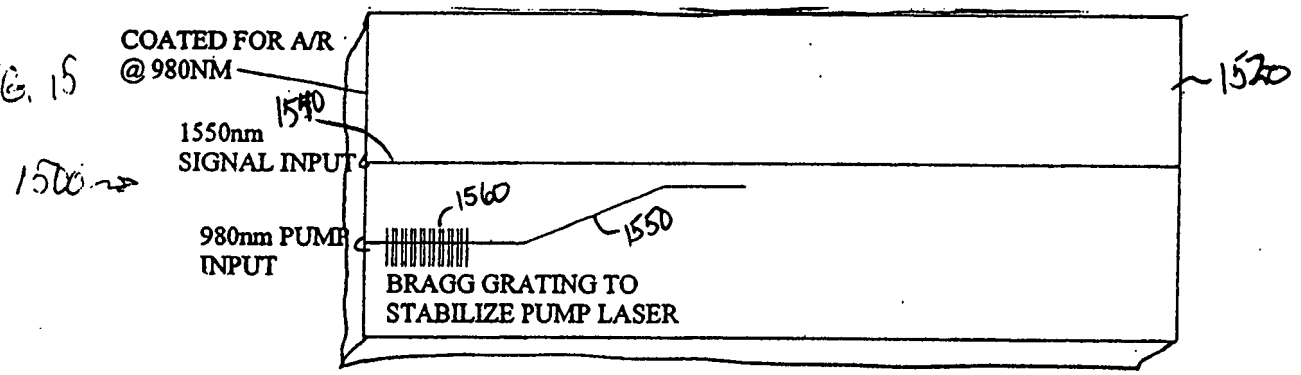

COATED FOR A/R
@ 980NM
1540
1550nm
SIGNAL INPUT
1500
1560
1550
980nm PUMP
INPUT
BRAGG GRATING TO
STABILIZE PUMP LASER
1520

FIG. 16

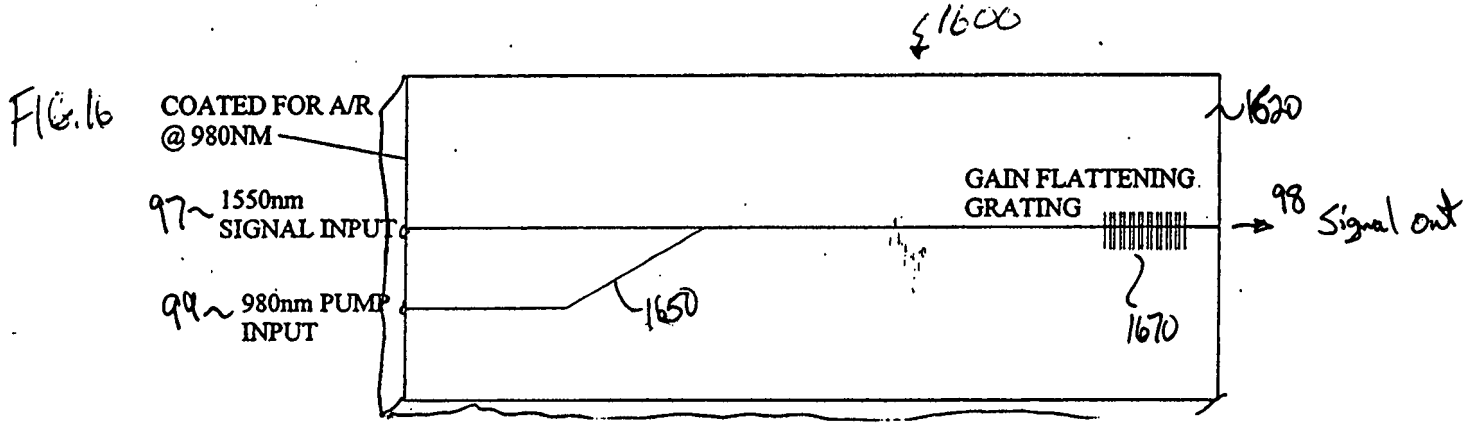

1600
COATED FOR A/R
@ 980NM
1620
GAIN FLATTENING
GRATING
97
1550nm
SIGNAL INPUT
98
Signal out
99
980nm PUMP
INPUT
1650
1670

FIG. 17

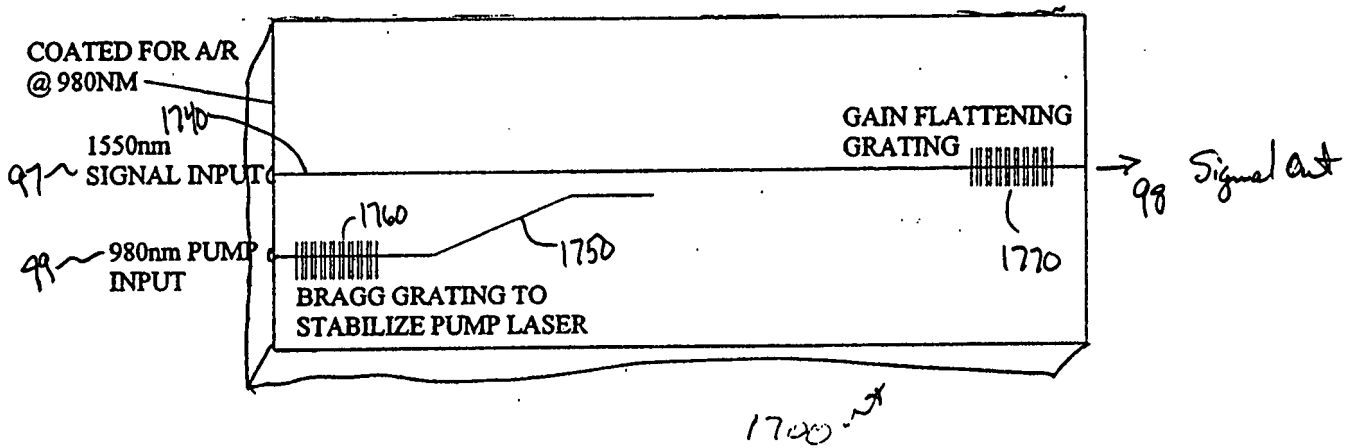

COATED FOR A/R @ 980NM
1740
1550nm SIGNAL INPUT
97
980nm PUMP INPUT
99
1760
1750
BRAGG GRATING TO STABILIZE PUMP LASER
GAIN FLATTENING GRATING
1770
98 Signal out
1700

FIG. 18

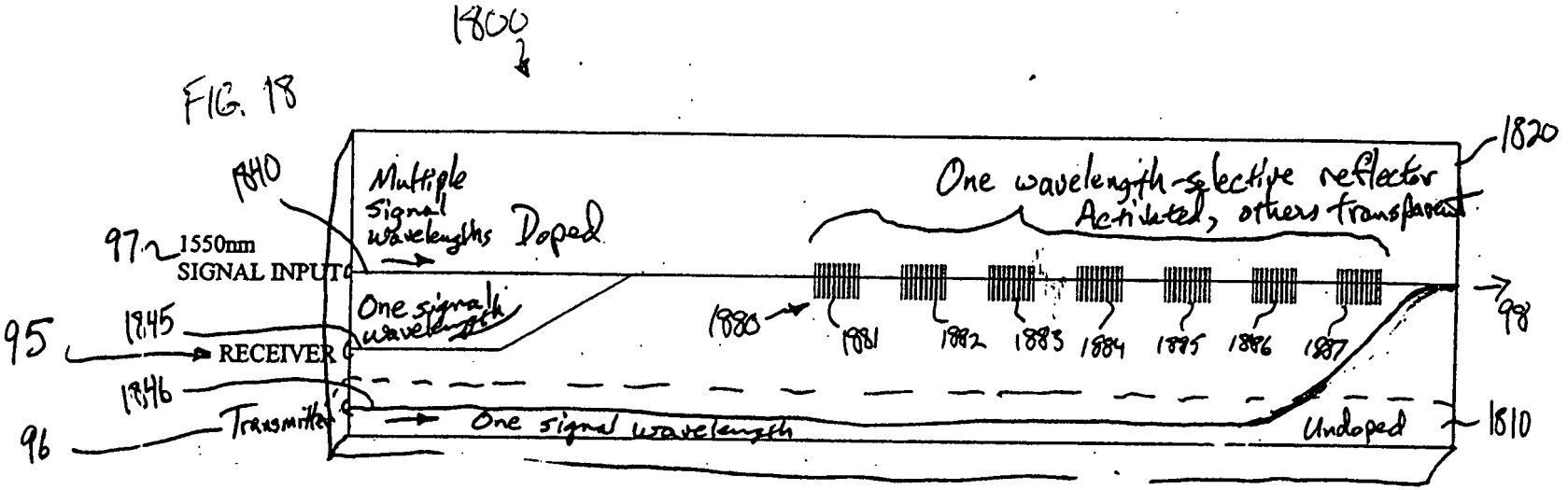

1800
1810
Multiple signal wavelengths Doped
1820
One wavelength-selective reflector Activated, others transparent
97 1550nm SIGNAL INPUT
One signal wavelength
1880
1881
1882
1883
1884
1885
1886
1887
98
95
1845
RECEIVER
1846
96
Transmitter
One signal wavelength
Undoped

FIG. 19

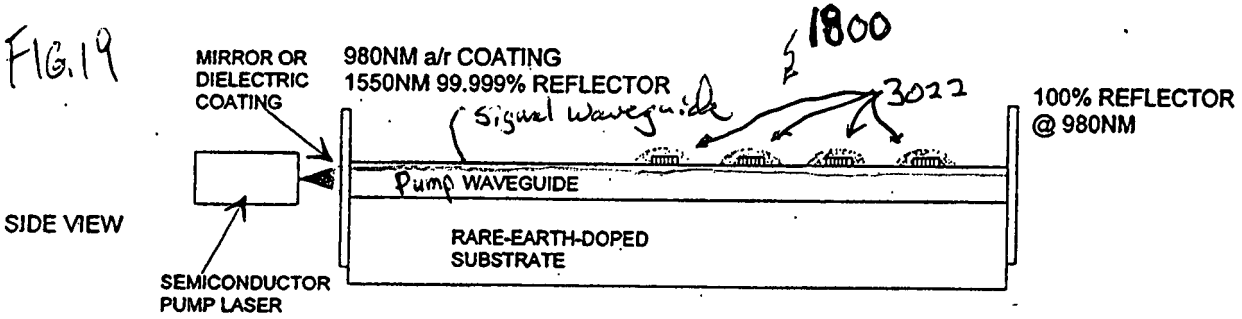
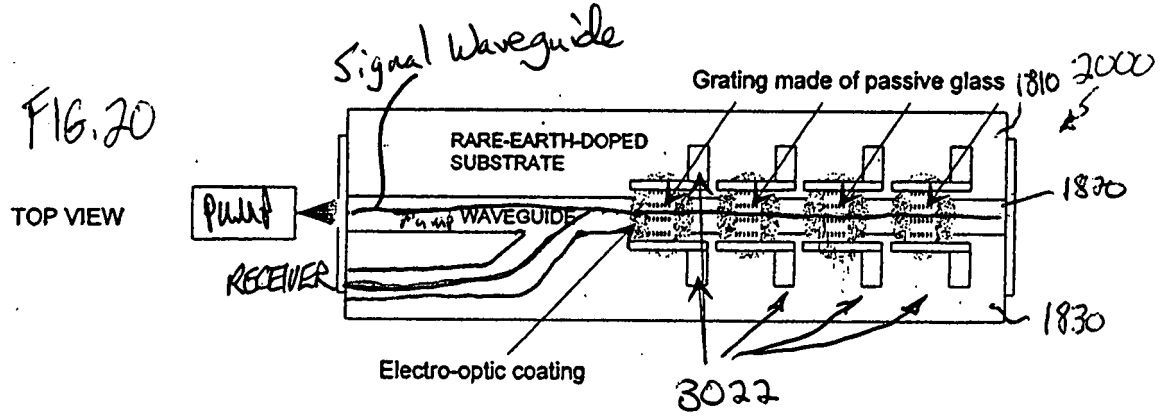

1800
MIRROR OR DIELECTRIC COATING
980NM a/r COATING
1550NM 99.999% REFLECTOR
Signal Waveguide
3022
100% REFLECTOR @ 980NM
Pump WAVEGUIDE
SIDE VIEW
RARE-EARTH-DOPED SUBSTRATE
SEMICONDUCTOR PUMP LASER

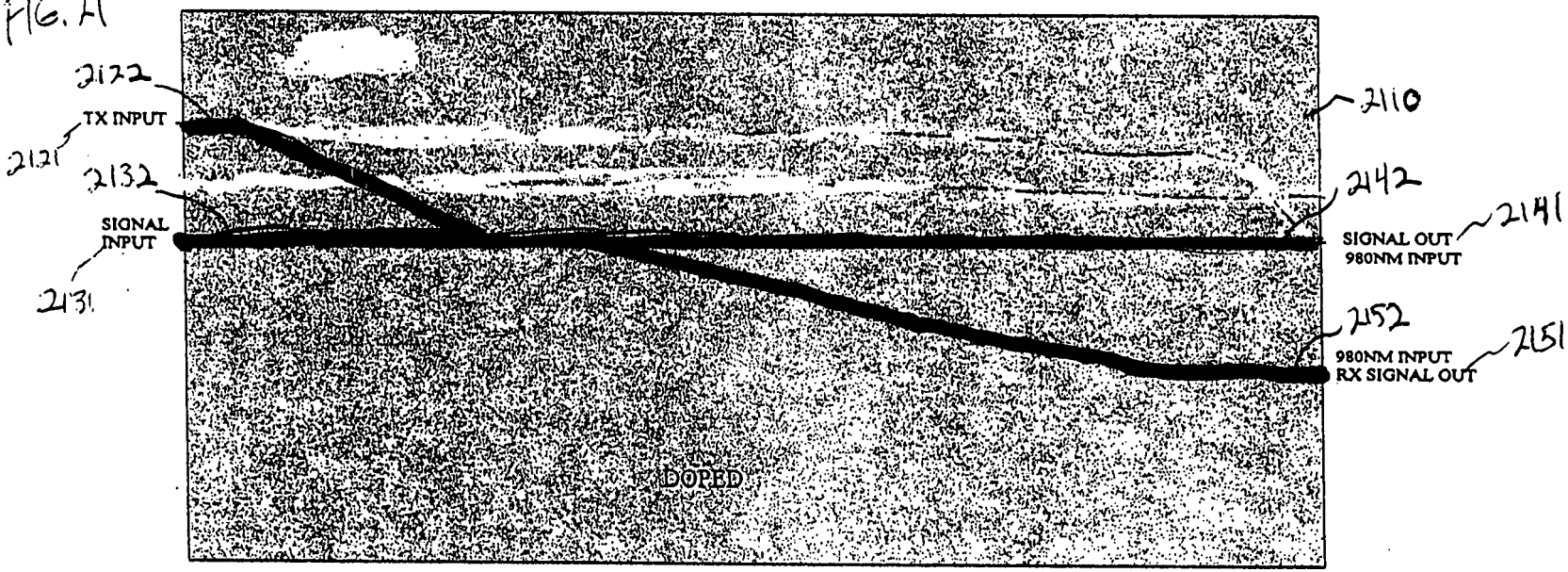
FIG. 20


Signal Waveguide
Grating made of passive glass
1810
2000
RARE-EARTH-DOPED SUBSTRATE
1820
TOP VIEW
Pump
Pump WAVEGUIDE
RECEIVER
1830
Electro-optic coating
3022

2100

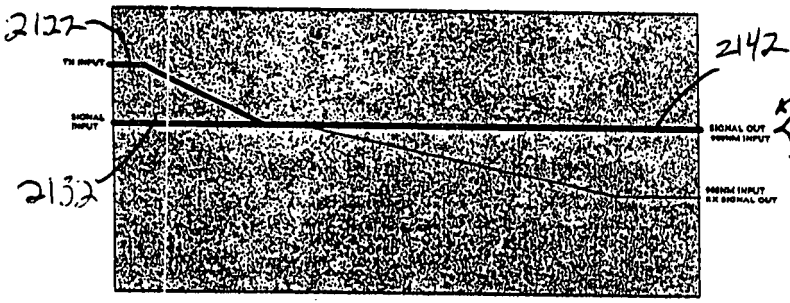
ADD/DROP NODE WITH AMPLIFICATION

FIG. 21



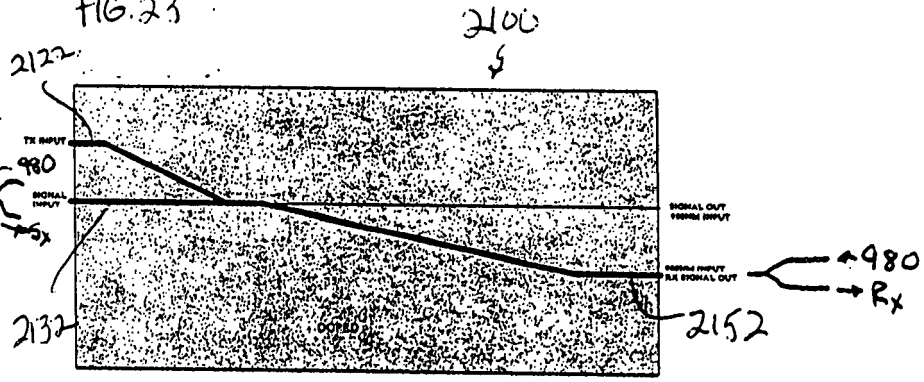
USES BOTH THE ATTENUATION AND AMPLIFICATION CHARACTERISTICS OF RARE-EARTH-DOPED GLASS TO ROUTE THE SIGNAL.

FIG. 22



AMPLIFIED BYPASS MODE (OLD SIGNAL PASSED STRAIGHT THROUGH)

FIG. 23



RECEIVE MODE (OLD SIGNAL OUT, NEW SIGNAL IN)

BOTH THE OUTPUT AND RX OUT COULD HAVE WDM'S OR SPLITTERS TO COMBINE THE 980 AND 1550 SIGNALS.

FIG. 24

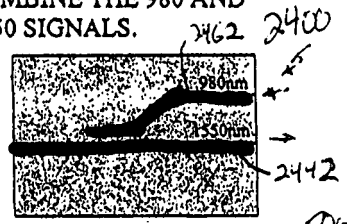
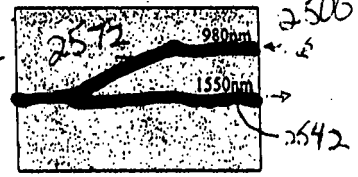


FIG. 25



ADD/DROP NODE WITH AMPLIFICATION

2600

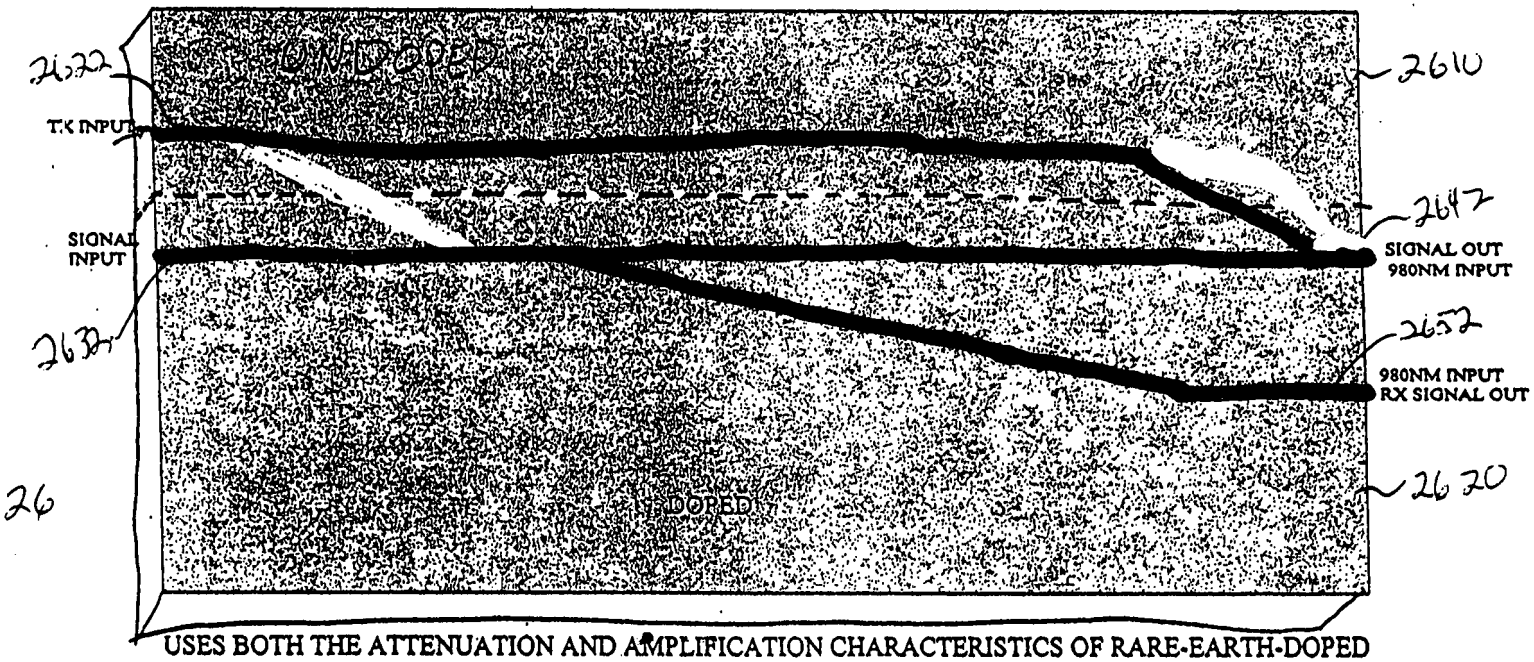


FIG. 26

USES BOTH THE ATTENUATION AND AMPLIFICATION CHARACTERISTICS OF RARE-EARTH-DOPED GLASS TO ROUTE THE SIGNAL.

ADD/DROP NODE WITH AMPLIFICATION

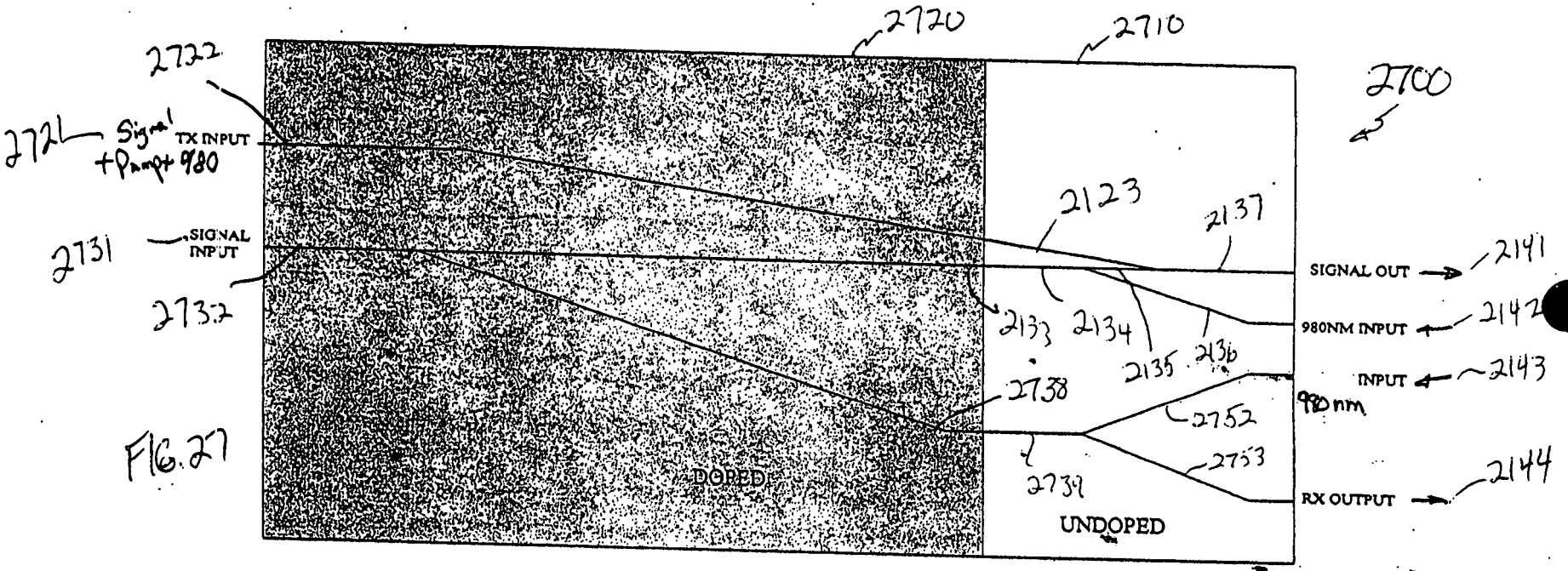
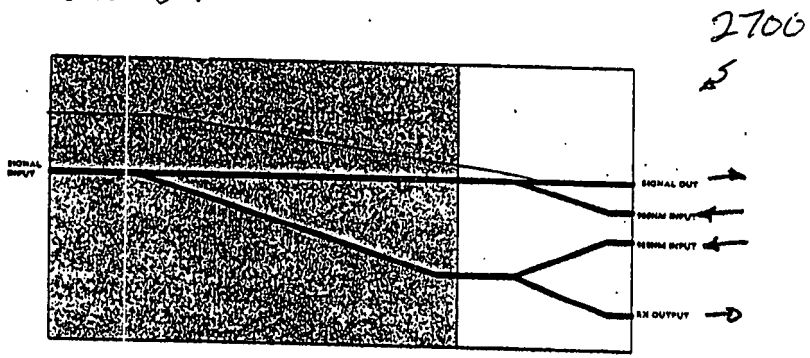


FIG. 27

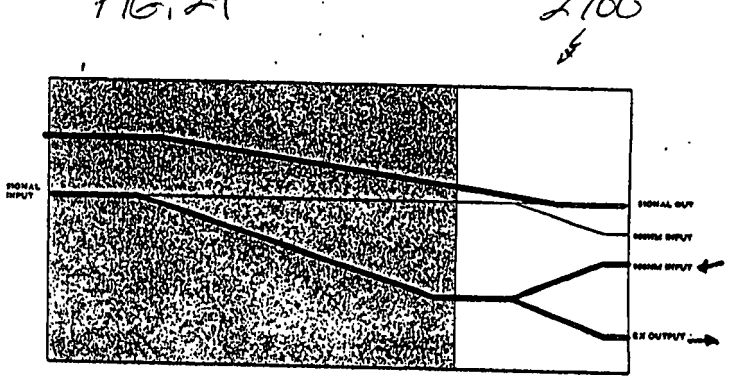
USES BOTH THE ATTENUATION AND AMPLIFICATION CHARACTERISTICS OF RARE-EARTH-DOPED GLASS TO ROUTE THE SIGNAL.

FIG. 28



AMPLIFIED PASS-THROUGH CONFIGURATION

FIG. 29



ATTENUATED PASSTHROUGH AND NEW SIGNAL INJECTED

FIG. 30

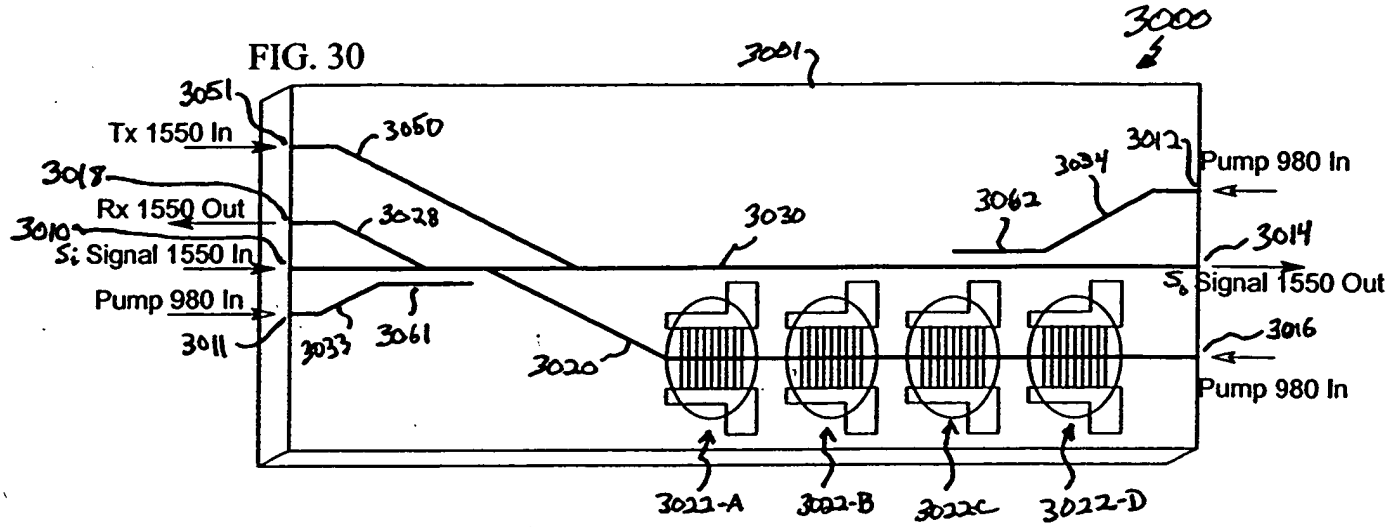


FIG. 31

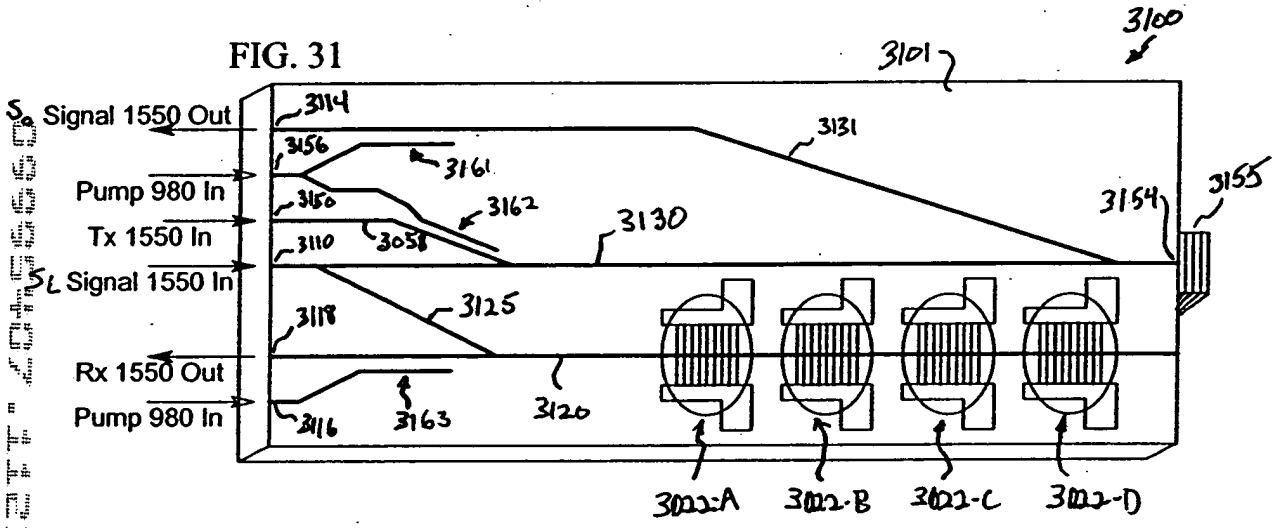


FIG. 32

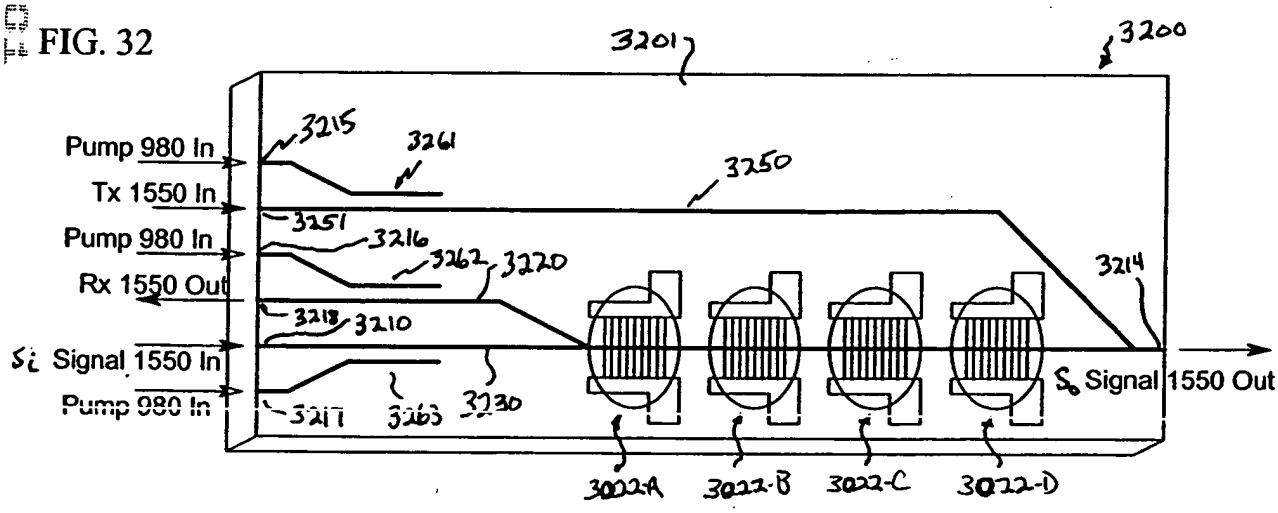


FIG. 33

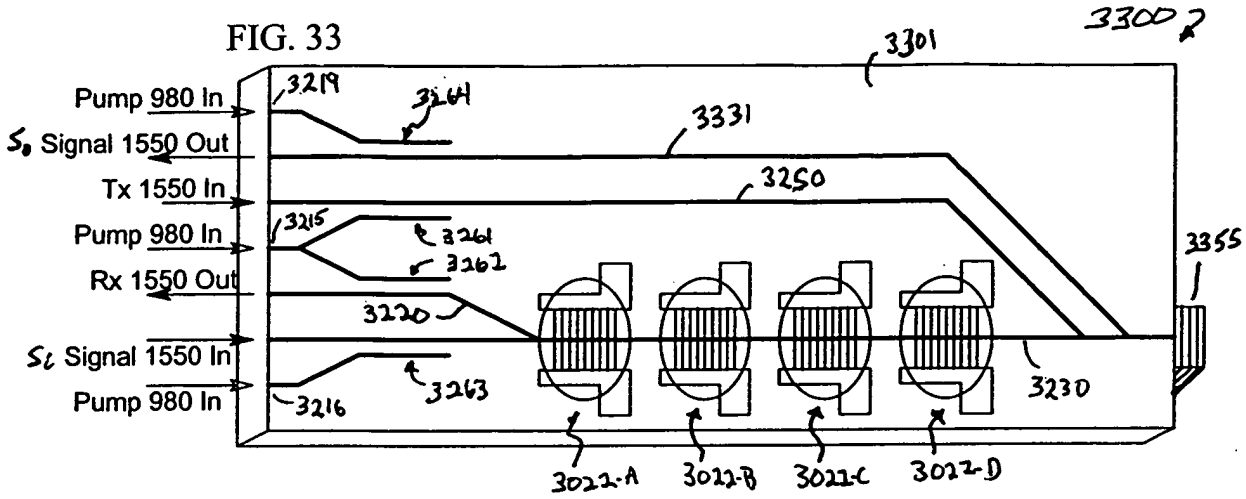


FIG. 34

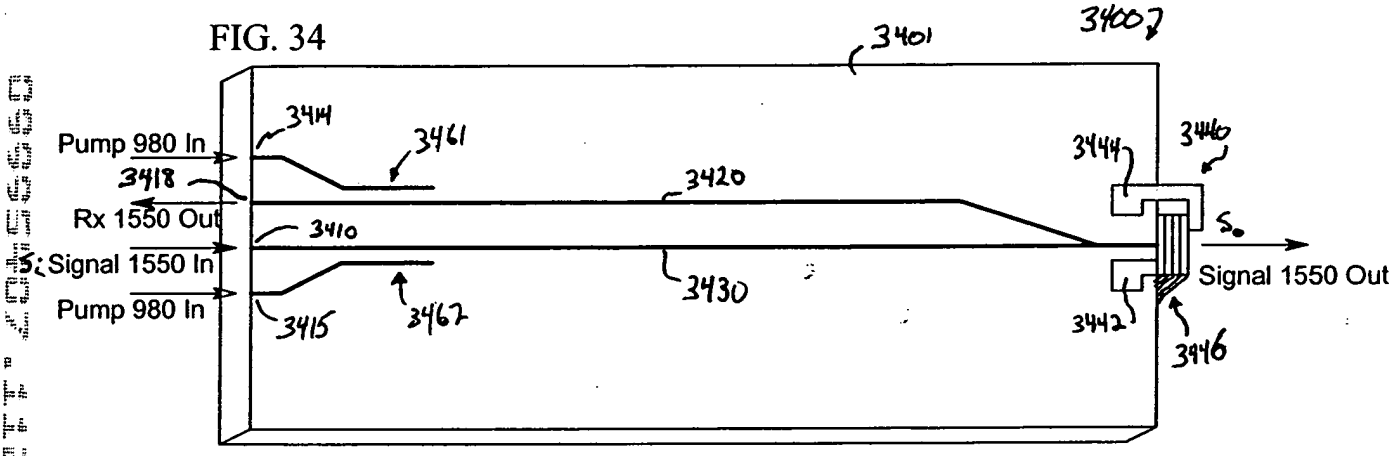


FIG. 35

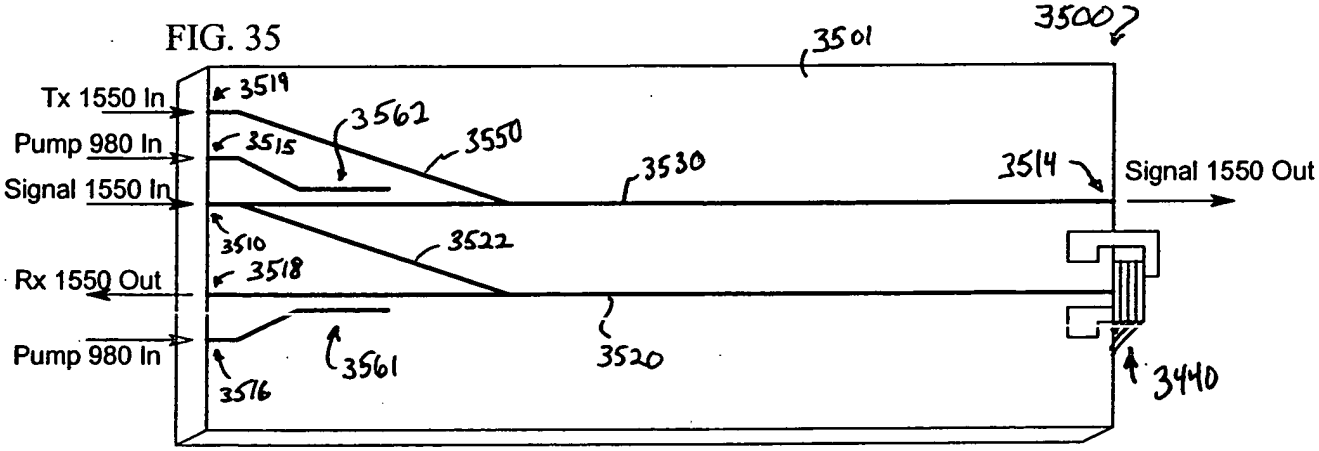


FIG. 36

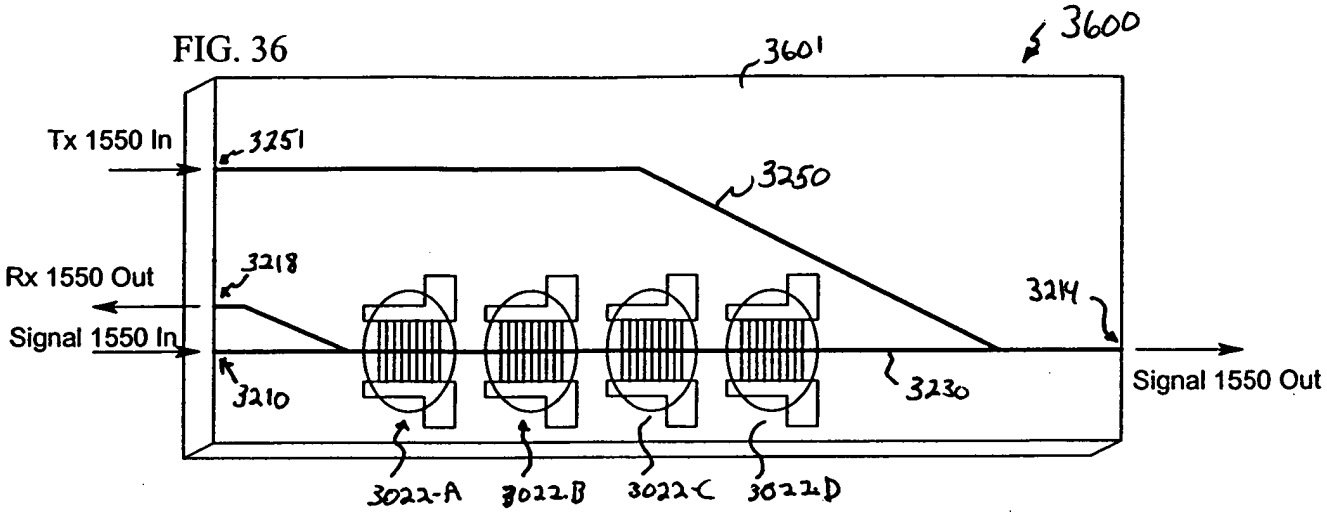


FIG. 37

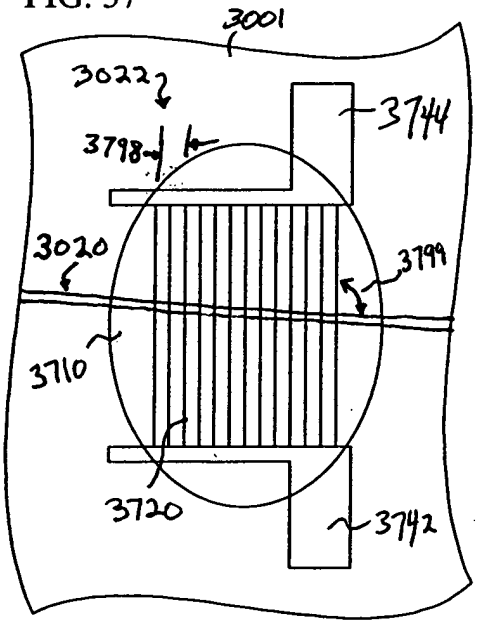


FIG. 38

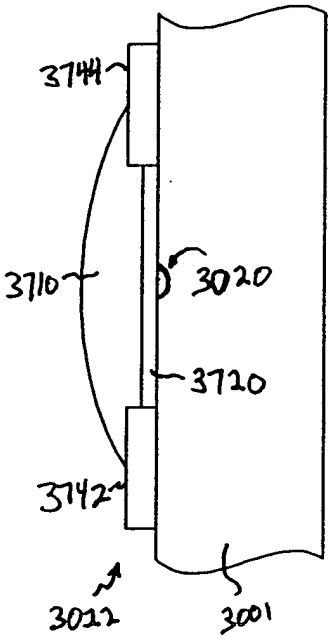


FIG. 39